DOCUMENT RESUME

ED 061 554 CG 007 160

AUTHOR	Barron, Richard F.
TITLE	The Effects of Advance Organizers upon the Reception Learning and Retention of General Science Content.
INSTITUTION	Syracuse Univ., N.Y.
SPONS AGENCY	Office of Education (DHEW), Washington, D.C.
BUREAU NO	BR-1B-030
PUB DATE	15 Nov 70
GRANT	OEG-2-710030
NOTE	37p.
EDRS PRICE	MF-$0.65 HC-$3.29
DESCRIPTORS	Classroom Techniques; *Experimental Teaching; Instruction; Learning; *Teaching; *Teaching Methods; *Teaching Models; Teaching Procedures; *Teaching Techniques

ABSTRACT

David P. Ausubel (1963, 1968) has developed a psychology of meaningful reception learning which is intimately related to instruction as it typically occurs in schools. A key component of this psychology involves the hypothesized effects of advance organizers has not been adequately evaluated. Previous investigations, while of theoretical interest, have merely demonstrated the equivocal nature of a poorly defined pedagogical tool in a number of situation-specific research settings. The present study attempted to rectify this state of affairs by: a) developing an operationally defined advance organizer, and b) testing the effects of this treatment relative to a traditional prose organizer in a cross-sectional research designs. Subjects in grades six through twelve were randomly assigned to three treatment conditions: graphic organizer, prose organizer, and control. Materials were aimed at the ninth grade population and held constant across the seven grade levels. Analysis of the data revealed no significant differences in favor of the organizer treatments as any of the seven grade levels. Apparently, within-grade subject variability negated the potential effects, if any, of the advance organizers. (Author/RK)

ED 061554

JAN 1972

BR-1-B-030

Approved 1/17/72
John Sokol
Dr. John Sokol
Director, Educational Research
DHEW-OFFICE OF EDUCATION - RM 1013
Federal Building
26 Federal Plaza
New York, New York 10007

Final Report

Project No. 1B-030
Grant No. OEG-2-710030

Richard F. Barron
Syracuse University'
Syracuse, New York, 13210

CG

CG 007 160

THE EFFECTS OF ADVANCE ORGANIZERS UPON THE RECEPTION LEARNING AND RETENTION OF GENERAL SCIENCE CONTENT

November 15, 1970

U. S. Department of Health, Education, and Welfare

Office of Education

National Center for Educational Research and Development
(Regional Research Program)

CG 007 160

FINAL REPORT

Project No. 1B-030
Grant No. OEG-2-710030

The Effects of Advance Organizers upon the Reception Learning and Retention of General Science Content

Richard F. Barron

Syracuse University
Syracuse, New York

November 15, 1971

The research reported herein was performed pursuant to a grant with the Office of Education U.S. Department of Health, Education, and Welfare. Contractors undertaking such projects under Government sponsorship are encouraged to express freely their professional judgment in the conduct of the project. Points of view or opinions stated do not, therefore, necessarily represent official office of Education position or policy.

U.S. DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE

Office of Education
National Center for Educational Research and Development

Table of Contents

		Page
LIST OF TABLES		v
I.	INTRODUCTION	1
	Problem Statement	1
	Problem Development	1
II.	PROCEDURES	5
	Subjects	5
	Design and Statistical Analysis	5
	Materials	5
	Treatment Implementation	7
III.	RESULTS	8
IV.	CONCLUSIONS AND RECOMMENDATIONS	13
APPENDICES		
A.	GRAPHIC ORGANIZER OPERATIONAL DEFINITION	14
B.	ORGANIZERS	16
C.	DIRECTIONS FOR TREATMENT IMPLEMENTATION	19
D.	ASTRONOMY TEST	25
E.	ITEM ANALYSIS OF ASTRONOMY TEST	30
REFERENCES		32

LIST OF TABLES

Table		Page
1	Previous Investigations of Advance Organizers	2
2	Schema of Design	6
3	Means (and Variances) across Treatments by Grade Level: Astrology Examination	8
4	Planned Comparison t Tests: Grade Six	9
5	Planned Comparison t Tests: Grade Seven	9
6	Planned Comparison t Tests: Grade Eight	10
7	Planned Comparison t Tests: Grade Nine	10
8	Planned Comparison t Tests: Grade Ten	11
9	Planned Comparison t Tests: Grade Eleven	11
10	Planned Comparison t Tests: Grade Twelve	12
11	Item Analysis of Astronomy Test	30

Introduction

Problem Statement

This study attempted to determine the effects of graphic and prose advance organizers at each of seven grade levels, six through twelve.

Problem Development

David Ausubel (1963, 1968) has developed an educational psychology that is intimately related to learning as it typically occurs in schools. At the core of this psychology is the proposition that a principal variable influencing new learning in a subject matter field is one's existing background of knowledge, or cognitive structure. Ausubel maintains that new meanings in any discipline are acquired only in relation to a previously learned background of relevant concepts and principles. Thus, if existing cognitive structure is clear, stable and organized, new learning will be enhanced. Conversely, if existing cognitive structure is unclear and disorganized, new learning will be impeded. Following this line of reasoning, Ausubel has argued that new learning and retention can be facilitated by strengthening relevant aspects of a learner's existing cognitive structure.

The use of "advance organizers" (Ausubel, 1960) has been proposed as one means of strengthening existing cognitive structure. As developed by Ausubel, advance organizers are introductory prose passages written at a higher level of "generality, abstraction, and inclusiveness" (1960, p. 272) than the actual learning material. These devices purportedly perform several functions. First, they "provide ideational scaffolding for the stable incorporation of more differentiated material in the learning passage" (1968, p. 148). Second, "they increase discriminability between the new material and similar or ostensibly conflicting ideas in cognitive structure" (1968, p. 148).

Although Ausubel's thinking is logically compelling, its implementation and evaluation have been beset by a number of problems.

First, advance organizers have not been accorded an operational definition. Clearly, what is sufficiently "general", "abstract", and "inclusive" varies from one situation to another. Thus, it has been difficult for teachers and researchers to know whether particular organizers were appropriate for their intended audience.

Second, in studying the effects of advance organizers, previous investigators have tended to concentrate upon basic rather than applied research. Although the results of these studies are theoretically interesting, the points at which advance organizers achieve practical utility have not been identified. Rather, previous research has consistently demonstrated the equivocal effects of a poorly defined treatment in a number of specific situations. (Table 1)

Table I

Previous Investigations of Advance Organizers

	Results	
	Supportive	Equivocal and/or Negative
Elementary		Carter et al, 1970 Proger et al, 1970
Junior High School		Triezenberg, 1968
High School	Fitzgerald and Ausubel, 1963 Estes et al, 1969	Jerrolds, 1967 Smith and Hess, 1969 Thelen, 1970 Proger et al, 1970
College	Ausubel, 1960 Ausubel and Fitzgerald, 1961 Murphy, 1962 Ausubel and Fitzgerald, 1962 Ausubel and Youssef, 1963 Scandura and Wells, 1967	Baumman and Glass, 1969
Adult	Grotelueshen and Sjogren, 1968	

The present investigation attempted to deal with the preceding problems by: (a) developing an operationally defined advance organizer designed to meet general conditions specified by Ausubel, and (b) testing the effects of this organizer relative to those of a traditional prose organizer in a "strong inference" (Platt, 1964) research design

Graphic Advance Organizers

Graphic organizers were first suggested under the rubric of "structured overviews" (Barron, 1969.) They have been defined as "visual and verbal presentations of the key vocabulary in a new learning task in relation to subsuming and/or parallel terms that presumably have previously been incorporated into the learner's cognitive structure" (Estes, Mills, and Barron, 1969, p.41). Graphic organizers have been based upon the same theoretical rationale as Ausubel's prose organizers and may be regarded as a "special form of advance organizer, the aim of which is to relate new concepts to be learned to the relevant body of related concepts already existing in cognitive structure".[1]

In contrast to prose organizers, graphic organizers appear to hold a number of advantages. First, unlike prose organizers, graphic organizers have been operationally defined. It has been ascertained that they can be constructed and used by combining a minimum of training with a relatively simple set of directions (Appendix A). Second, whereas prose organizers are designed to be read by learners, graphic organizers call for an interaction between teacher and students. Thus, when using the latter device, a teacher is able to evaluate its appropriateness in relation to the learners' existing background of knowledge.

Strong inference.

Platt (1964), among others, has called for the application of research procedures used in "fast moving fields" to educational studies. One of these techniques has been termed "strong inference." Rather than continually measuring, defining, computing, and analyzing the same theoretical ground, the researcher attempts to refine crucial experiments aimed at disproving his hypotheses.

While the overall utility of this approach in educational research is open to question, it can be valuable within certain limits. By developing a series of studies in terms of gradually refined populations and control variables, the educational researcher is able to indicate the degree to which a particular theoretical orientation achieves practical utility.

The present study attempted to initiate the preceding in the following way. Ausubel (1968) has indicated that there are two conditions under which an advance organizer fails to perform its intended function. The first occurs when the learner is so lacking in background

[1] David P. Ausubel: Personal correspondence (September 30, 1969).

relevant to the learning task that there is little, or nothing, in his cognitive structure to be organized. The second situation occurs when the learner is so well grounded in background relevant to the learning task that provision of the organizer becomes superfluous.

These ideas were tested in the present study by holding both the learning task and organizer treatments constant across seven grade levels and aiming these materials at the middle level. It was anticipated that if Ausubel's thinking was correct an s-shaped learning curve would appear across the several grade levels. That is, the organizers should have initially demonstrated little or no effect due to the weak and unstable cognitive structures of the younger subjects. This effect should have gradually increased to some maximum point. Finally, it should have dissipated with older subjects who presumably would have well organized cognitive structures in relation to the learning task.

If, on the other hand, Ausubel's assertions were something less than generally applicable, it was anticipated that the learning curve across grade levels would resemble a straight or slightly curved line. In other words, subject variability within grades would negate the patential benenfits of the organizer treatments.

Procedures

Subjects

The study was conducted with students enrolled in grades six through twelve in the Tully, New York Central Schools. This system is located in upper Central New York State and its students are drawn from rural and suburban environments. Excluded from the study were pupils classified as emotionally disturbed or mentally retarded, and those who were not in attendance during treatment implementation.

Design and Statistical Analysis

The basic design for the study was a "posttest-only control group design" (Campbell and Stanley, 1963). Although the schematic representation of this design (Table 2) appears to be factorial, tests of significance for overall main effects and interactions were not of direct interest. Rather, the intent of the study was to explore potential specific interactions (in a non-factorial sense) between methods of cognitive organization and grade level.

In order to accomplish this purpose, two orthogonal planned comparisons were posited at each grade level. The first comparison contrasted the average effects of the combined organizer treatments with those of the control. The second compared the effects of the two organizer treatments.

Materials

Learning passage. The learning passage[2] was selected primarily on the basis of its relevance to the regular eighth grade science curriculum at the Tully Central Schools. It was approximately 2300 words in length and it dealt with the characteristics of stars. The readability level of this passage was placed at approximately an eighth grade level as determined by the Flesch Formula.

Organizers. The graphic and prose organizers used in the study are presented in Appendix B. Both types of organizer: (a) reviewed terminology used in making comparisons, (b) related the process of comparing people to the process of comparing stars, and (c) introduced various characteristics upon which the comparison of stars is based.

Outcome measure. The outcome measure, termed the "astronomy test," consisted of twenty-four multiple choice items. This instrument is included in Appendix D.

2 Adapted from: Deitz, D. Stars and the Universe, New York: Random HOuse, 1968.

Table 2

Schema of Design

Grade Level	Treatments: Graphic Organizer	Prose Organizer	Control
Sixth			
Seventh			
Eighth			
Ninth			
Tenth			
Eleventh			
Twelfth			

In developing the astronomy test the following procedures were undertaken. First, a table of specifications was constructed which took into account the content of the learning passage and used 'knowledge and 'comprehension" as broad objectives (Bloom, 1956). Second, an item pool consisting of thirty-five items was developed and submitted to three judges to determine how well the test reflected its intended objectives. A particular item was dropped if the three judges were not in unanimous agreement as to its classification in either the knowledge or comprehension categories. This procedure resulted in a reduced pool of twenty-nine items. Third, the learning passage and outcome measure were administered to a sample of ninth grade students. Following the computation of item difficulty indices, item discrimination indices, and item correlations with the total test, five additional items were dropped. Based upon this tryout the test yielded an internal consistency coefficient of .78.

An additional precaution was taken to guard against the possibility that information included in the organizer treatments would be directly relevant to the astronomy test. The three experimental treatments (i.e. graphic organizer, prose organizer and control) were administered to a sample of students without the learning passage. On the subsequent administration of the astronomy test, the means of these three groups were nearly identical and none of the three groups scored beyond what might have been expected on a chance basis. Therefore, it was assumed that the organizer treatments contained no information that would directly assist subjects in responding to the astronomy test.

Treatment Implementation

Administration of treatments occurred during each subject's regularly scheduled English class. Subjects were randomly assigned, within classes, to the three experimental groups. On the day of treatment implementation for their class, the subjects in each group reported to one of three special rooms. At this time, they received one of the three treatments and read the learning passage.

A maximum time of five minutes was alloted for presentation of the organizers, and the subjects were allowed twenty-five minutes to read and review the learning passage.

On the day following administration of treatments, students returned to their regularly scheduled English class where they responded to the astronomy test.

Results

The means and variances for each of the experimental groups are presented by grade levels in Table 3. For the total group, the scores ranged from three to twenty-three with a mean of 9.50 and a variance of 14.78

Table 3

Means (and Variances) across Treatments
by Grade Level: Astronomy Examination

Grade	Treatments		
	Graphic Organizer	Prose Organizer	Control
Six	7.77 (7.78)	7.36 (11.42)	8.60 (15.31)
Seven	8.79 (15.96)	8.77 (14.33)	8.53 (10.33)
Eight	8.47 (10.26)	8.86 (13.36)	9.56 (14.45)
Nine	8.69 (8.03	9.57 (15.85)	9.38 (13.66)
Ten	10.35 (16.98)	9.67 (13.63)	9.92 (16.58)
Eleven	12.14 (14.14)	11.36 (14.99)	10.55 (13.09)
Twelve	11.31 (13.30)	12.80 (19.31)	11.21 (15.52)

Results of significance tests at each grade level are presented in Tables 4 through 10. At each grade level, two hypotheses were of interest. Stated in null form, they were:

$H_0 1$ On a twenty-four hour delayed test of learning and retention, there will be no significant difference between students who receive either a graphic or a prose organizer prior to the learning task and students who do not receive an advance organizer.

Ho2: On a twenty-four hour delayed test of learning and retention, there will be no significant difference between students who receive a graphic organizer and students who receive a prose organizer prior to the learning task.

Table 4

Planned Comparison t Tests: Grade Six

Comparison	ψ	est. var. ($\hat{\psi}$)	df	t
G-O + P-O versus Control	-1.034	2.568	85	-0.40
G-O versus P-O	0.419	3.029	56	0.14

Table 5

Planned Comparison t Tests: Grade Seven

Comparison	ψ	est. var. ($\hat{\psi}$)	df	t
G-O + P-O Versus Control	0.247	3.025	86	0.08
G-O versus P-O	0.27	3.51	57	0.01

Table 6

Planned Comparison t Tests: Grade Eight

Comparison	ψ	est. var. ($\hat{\psi}$)	df	t
G-O + P-O versus Control	-0.913	2.73	95	-0.33
G-O versus P-O	-0.41	3.18	63	-0.13

Table 7

Planned Comparison t Tests: Grade Nine

Comparison	ψ	est. var. ($\hat{\psi}$)	df	t
G-O + P-O versus Control	-0.248	2.711	91	-0.91
G-O versus P-O	-0.879	3.160	60	-0.28

Tab;e 8

Planned Comparison t Tests: Grade Ten

Comparison	ψ	est. var. ($\hat{\psi}$)	df	t
G-O + P-O versus Control	0.088	3.931	67	0.02
G-O versus P-O	0.684	4.746	42	0.14

Table 9

Planned Comparison t Tests: Grade Eleven

Comparison	ψ	est. var. ($\hat{\psi}$)	df	t
G-O + P-O versus Control	1.196	3.941	61	0.30
G-O versus P-O	0.782	4.196	44	0.19

Table 10

Planned Comparison t Tests: Grade Twelve

Comparison	ψ	est.var. ($\widehat{\psi}$)	df	t
G-0 + P-0 versus Control	0.446	4.637	47	0.10
G-0 versus P-0	-0.688	5,721	29	-0.12

As indicated in Tables 4 through 10, no significant differences occurred atany of the seven grade levels. Thus, none of the fourteen null hypotheses were rejected.

A major limitation of the study involved recomputation of test reliability for the total sample. The Kuder Richardson formula 20 yielded an internal consistency coefficient of .69.

Conclusions and Recommendations

The present investigation addressed the question: "Are Ausubel's theoretical assertions regarding the facilitative effects of advance organizers generally applicable?" Insofar as learning tasks of the type implemented in this study are concerned, the answer appears to be no. Apparently, within-grade student variability precludes large scale usage of advance organizers as instructional tools.

Subsequent studies, in keeping with the previously described "strong inference" process, should focus upon the question: "Who, if anyone are advance organizers appropriate for?" In the opinion of the present investigator, such studies should be restricted to consideration of personological variables which are: (a) readily identifiable by classroom teachers and (b) useful as a means of differentiating instruction.

APPENDIX A: GRAPHIC ORGANIZER

OPERATIONAL DEFINITION

STEPS IN CONSTRUCTING AND USING
GRAPHIC ORGANIZERS

1. Analyze the vocabulary of the learning task and list all the words that you feel are important for the students to understand.

2. Arrange the list of words until you have a schema which depicts the interrelationships among the concepts particular to the learning task.

3. Add to the schema vocabulary terms which you believe are understood by the students in order to depict relationships between the learning task and the discipline as a whole.

4. Evaluate the organizer. Have you clearly depicted major relationships? Can the overview be simplified and still effectively communicate the ideas you consider to be crucial?

5. Introduce the students to the learning task by displaying the schema and informing them why you arranged the terms as you did. Encourage them to contribute as much information as possible.

6. During the course of the learning task, relate new information to the organizer as it seems appropriate.

APPENDIX B: ORGANIZERS

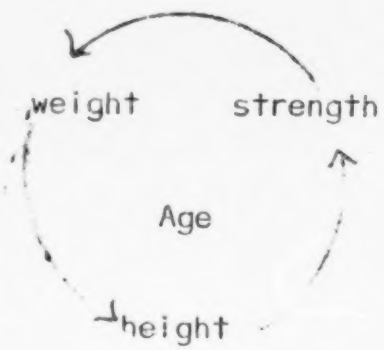
GRAPHIC ORGANIZER

SIMILAR - DIFFERENT

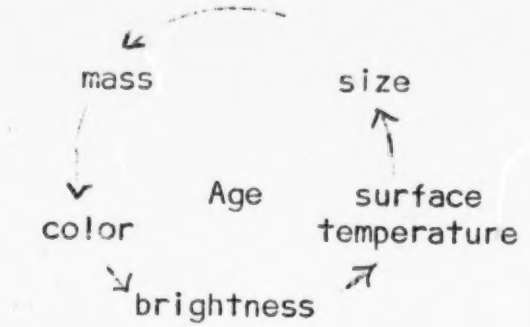
COMPARISONS

People

Stars



Body builds (somatotypes)



H-R diagram

Prose Organizer

Two words which scientists find extremely useful are 'similar' and "different." These terms assist them in making comparisons.

Various characteristics may serve as the basis for a comparison. For example, you might compare people on the basis of similarities or differences in their relative height, weight, or strength. You might also base your comparison on more than one measure. If you considered height and weight together, you could compare people on the basis of their body build.

In like fashion, astronomers use the terms 'similar' and 'different' to make comparisons between stars. However, comparisons between stars and made on the basis of color, brightness, surface temperature, size and mass, rather than height, weight, or strength. Astronomers can also base their comparisons on more than one measure. Stars can be compared on the basis of both color and brightness through the use of something astronomers call an H-R diagram.

Stars, like people, appear to change as they get older. Suppose you were interested in finding out how people's height changes as they get older. You could do this in several ways. One way to do it is to take groups of people of various ages, measure their height, and compare differences in height between the various age groups. In like fashion, astronomers determine how stars change as they get older. Within certain limits, the astronomers can approximate the ages of various stars. Then they compare older and younger stars in terms of characteristics such as size, color, etc. In this way astronmers can hypothesize about how stars change with age.

APPENDIX C: DIRECTIONS FOR TREATMENT IMPLEMENTATION

Treatment A: Graphic Organizer

A. TAKE ATTENDANCE

B. Introduction: Inform students that
   1. They are taking part in a research study.
   2. They will read a short passage today and will be tested on the information tomorrow.
   3. We are trying to find out how different types of introductions to reading material helps people understand and remember that they read.
   4. They should try to keep the introduction you are about to present in mind as they read the selection.

C. Presentation of Graphic Organizer
   1. Display terms "Similar-Different." Ask the students when or why we use such words (i.e., in making comparisons).
   2. Display the term "Comparisons."
      Say: "We can make comparisons between two or more things so long as they have certain characteristics in common. For example, what are some of the ways in which we can compare people?" Allow students to respond.
   3. Display portion of organizer relating to comparisons between people.
      Say:
      a. "You have indicated a number of ways in which people can be compared. I've indicated several of these in this diagram."
      b. "Please notice two things that I've tried to show through the diagram. First, the bases for our comparisons frequently vary according to the age of the individuals being compared. For example: as people get older, their weight, height, and strength changes. Second, note that we can sometimes base our comparisons on more than one measure. For example: to compare people on the basis of their body builds we would consider both height and weight."
   4. Display portion of diagram relating to comparisons between stars.
      Say:
      a. "The selection you will read today is from the field of astronomy and is concerned with the characteristics of stars."
      b. "Astronomers use the terms similar and different to make comparisons between stars. However, comparisons between stars are made on the basis of their relative: mass, size, surface temperature, brightness and color, rather than height, weight, etc."

c. "Notice two things about this diagram. First, as with people, the characteristics of stars change with age. Second, astronomers can also base their comparisons on combinations of measures of different characteristics. For example: Stars can be compared on the in terms of both color and brightness through the use of something called an H-R diagram."

D. Reading: 25 minutes (collect materials)

Treatment B: Prose Organizer

A. TAKE ATTENDANCE

B. Introduction: Inform students that
   1. They are taking part in a research study.
   2. They will read a short passage today and will be tested on the information tomorrow.
   3. We are trying to find out how different types of introductions to reading material helps people to understand and remember what they read.

C. Presentation of Prose Organizer
   1. Inform students that they will be reading a selection from astronomy concerned with the characteristics of stars.
   2. Distribute organizer
      Say:
      a. "Here is the introduction to the reading passage. Read it carefully and try to keep it in mind as you read the longer passage."
      b. "When you have finished the introduction, raise your hand and I will give you the reading selection."

D. Reading
   1. Collect organizer as you distribute passage.
   2. Allow 25 minutes and collect passage.

Treatment C: Control

A. TAKE ATTENDANCE

B. Introduction: Inform students that
   1. They are taking part in a research study

   2. They will read a short passage today from the field of astronomy concerned with the characteristics of stars. Tomorrow they will be tested on this information.

C. Reading: Allow 25 minutes and collect materials

Test Administration

1. Have students assist you in distributing pencils and answer sheets
2. Have students indicate:
   a. Their name
   b. Their grade
   c. Their teacher's name
   d. Their class period
3. Inform students:
   a. The test consists of multiple choice items
   b. The test should not take the entire period to complete
4. Distribute tests: Allow about 25 minutes for completion
5. Check to see that students have supplied correct information on answer sheet (of #2)
6. Collect all materials

APPENDIX D: ASTRONOMY TEST

Directions: Place your name your teacher's name, and your grade in the appropriate space on the answer sheet. For each question place a mark in the space provided on the answer sheet which represents the best answer for that question.

1. The H-R diagram indicates that
   a. There are stars with all combinations of brightness, surface temperature, size, and mass.
   b. As one descends the main sequence, the stars become progressively hotter.
   c. Most stars are in the giant sequence.
   d. The hottest stars are in the dwarf sequence.
   e. None of the above.

2. On the H-R diagram, our sun is placed
   a. In the center of the giant sequence
   b. Among the white dwarfs
   c. At the top of the main sequence
   d. At the bottom of the main sequence
   e. None of the above

3. Stars differ least in
   a. Brightness
   b. Size
   c. Mass
   d. Surface temperature
   e. Life span

4. The color of the hottest stars is
   a. Blue
   b. Red
   c. Orange
   d. Yellow
   e. White

5. Stars are placed in the H-R diagram according to their
   a. Brightness and luminosity
   b. Luminosity and color
   c. Temperature and size
   d. Color and size
   e. None of the above

6. What causes stars to assume the shape of a sphere?
   a. Heat
   b. Gravity
   c. Atomic energy
   d. Mass
   e. Particle attraction

7. Which of the following occurs in highly luminous stars?
   a. Conversion of helium into carbon
   b. Conversion of hydrogen into helium
   c. Conversion of carbon into heavier elements
   d. All of the above
   e. None of the above.

8. A star will remain stable until
   a. It becomes a nova
   b. It converts all the hydrogen in its central region into helium
   c. Its temperature reaches 100 million degrees
   d. It converts all the helium in its outer region into carbon
   e. None of the above

9. If a proto-star is exceedingly large, the star formed will at first be a
   a. Yellow dwarf star
   b. Blue star
   c. White star
   d. Red dwarf star
   e. Either b or c

10. Compression of gas and dust particles in a globule causes a (n)
   a. Increase in temperature
   b. Decrease in mass
   c. Loss of color
   d. Increase in area
   e. All of the above

11. Which of the following statements about the age of stars is false
   a. Most stars are 10 or 20 million years old
   b. Some stars in our galaxy are in the process of being formed
   c. Highly luminous stars usually have a shorter life span than less luminous stars
   d. Some stars in our galaxy are in the process of dying
   e. None of the above (all the statements are true)

12. Which of the following statements about the temperature of stars is false?
   a. Surface temperatures between stars range from 5000 - 100,000 degrees Fahrenheit
   b. The temperature at the center of some stars may reach 10 million degrees Fahrenheit
   c. The temperature of a star fluctuates during its life span
   d. Surface temperature is unrelated to color
   e. None of the above (all statements are true)

13. Which of the following statements about the color of stars is false?
    a. A star may have several colors during its life span
    b. Surface temperature is unrelated to color
    c. The colors of stars are more pronounced when viewed through a telescope
    d. Blue stars are hotter than yellow stars
    e. None of the above (all the statements are true)

14. Which of the following statements about the size of stars is false?
    a. The largest stars have diameters 3,000 times greater than the sun
    b. The size of a star depends upon the size of the gas and dust cloud from which it is originally formed
    c. Stars differ more in size than they do in mass
    d. The smallest stars have diameters about 400 times less than the sun
    e. None of the above (all the statements are true)

15. The brightest stars are
    a. First magnitude
    b. Second magnitude
    c. Third magnitude
    d. Fourth magnitude
    e. Tenth magnitude

16. Which of the following statements about the brightness of stars is false?
    a. Some stars are 1 million times brighter than the sun
    b. Some stars are 1 million times fainter than the sun
    c. Stars differ more in brightness than they do in mass
    d. Stars differ less in brightness than they do in apparent magnitude
    e. None of the above (all the statements are true)

17. About how many stars are visible to the naked eye from any one point on earth
    a. 2000
    b. 6000
    c. 100,000
    d. Half a million
    e. Many billions

18. The color of the coolest stars is
    a. Blue
    b. Red
    c. Orange
    d. Yellow
    e. White

19. Differences in the colors between stars is directly due to
    a. Size
    b. Mass
    c. Age
    d. Brightness
    e. None of the above

20. Which of the following stars might not be found in the main sequence?
    a. Blue dwarf star
    b. White dwarf star
    c. Yellow dwarf star
    d. Orange dwarf star
    e. Red dwarf star

21. A nova is a (n)
    a. Star that can no longer be placed on the H-R diagram
    b. Exploding star
    c. Star that is invisible
    d. Mature star
    e. Newly born star

22. The scale by which stars are ranked according to their brightness is arranged so that there is a difference in brightness of_____ times between magnitudes.
    a. 1/100
    b. 2 1/2
    c. 6
    d. 100
    e. None of the above

23. The mass of an object is
    a. It's relative size compared to the sun
    b. It's weight
    c. The amount of matter it contains
    d. Dependent upon gravity
    e. None of the above

24. The most luminous stars are_____times as luminous as the sun.
    a. 50
    b. 3000
    c. 5000
    d. 100,000
    e. One million

APPENDIX E: ITEM ANALYSIS --

ASTRONOMY TEST

TABLE II

Item Analysis of Astronomy Test

Item	Difficulty	Discrimination	Point Biserial
1	.13	.23	.29 (.01)
2	.31	.48	.42 (.01)
3	.31	.37	.35 (.01)
4	.67	.53	.44 (.01)
5	.27	.21	.22 (.01)
6	.50	.43	.37 (.01)
7	.37	.28	.26 (.01)
8	.29	.42	.36 (.01)
9	.50	.30	.22 (.01)
10	.52	.56	.42 (.01)
11	.19	.22	.23 (.01)
12	.50	.53	.43 (.01)
13	.54	.57	.46 (.01)
14	.31	.41	.38 (.01)
15	.66	.33	.31 (.01)
16	.31	.33	.28 (.01)
17	.21	.10	.12 (.01)
18	.46	.65	.50 (.01)
19	.33	.55	.46 (.01)
20	.27	.26	.25 (.01)
21	.40	.53	.42 (.01)
22	.32	.20	.21 (.01)
23	.31	.27	.26 (.01)
24	.41	.30	.22 (.01)

References

Ausubel, D.P. The use of advance organizers in the learning and retention of meaningful verbal material. Journal Educational Psychology, 1960, 51, 267-272.

Ausubel, D.P., The psychology of meaningful verbal learning. New York: Grune and Stratton, 1963.

Ausubel, D.P., Educational psychology: A cognitive view. New York: Holt, Rinehard, and Winston, Inc., 1968.

Ausubel, D.P. and Fitzgerald, D.,Organizer, general background and antecedent learning variables in sequential verbal learning. Journal of Educational Psychology, 1962, 53, 243-249.

Ausubel, D.P. and Youssef, M., Role of discriminability in meaningful parallel learning. Journal of Educational Psychology, 1963, 54, 331-336.

Barron, R. F., The use of vocabulary as an advance organizer. In H.L. Herber and P.L. Sanders (Eds.), Research on reading in the content area: First year report. Syracuse, N.Y.: Syracuse University Press, 1969.

Baumman, D.J. and Glass, G.V., The effects on learing of the position of an organizer. Paper presented at the meeting of the American Educational Research Association. February, 1969.

Bloom, B.S. (Ed.) Taxonomy of educational objectives: Cognitive domain. New York: David McKay Company, Inc., 1956.

Campbell, D. T., and Stanley, J.C., Experimental and quasi-experimental designs for research on teaching. In N.L. Gage (Ed.), Handbook of research on teaching. Chicago: Rand McNally and Company, 1963.

Carter, C.E., Proger, B.B., Mann, L. & Haughey, C.F., The relationships between advance organizers for sixth-grade reading selections, reading level, and sex. Paper presented at the meeting of the American Educational Research Association, Minneapolis, February 1970.

Earle, R.A., use of the structured overview in mathematics classes. In H.L. Herber and P.L. Sanders (Eds.), Research on reading in the content area: First year report. Syracuse, N.Y.: Syracuse University Press, 1969.

Estes, T.H., Mills, D.N., and Barron, R.F., Three methods of intruducing students to a reading-learning task in two content subjects. In H.L. Herber and P.L. Sanders (Eds.), Research on reading in the content area: First year report. Syracuse, N.Y: Syracuse University Press, 1969.

Fitzgerald, D. and Ausubel, D.P., Cognitive versus affective factors in the learning and retention of controversial material. Journal of Educational Psychology, 1963, 54, 73-84.

Grotelueshen A. and Sjogren, D.D., Effects of differentially structured introductory materials and learning tasks on learning and transfer. American Educational Research Journal, 1968, 5, 191-202.

Hays, W.L., Statistics for psychologists. New York: Holt, Rinehart, and Winston, Inc., 1963.

Jerrolds, B. W., The effects of advance organizers in reading for the retention of specific facts. Unpublished doctoral dissertation, University of Wisconsin.

Kick, R. E., Experimental design: Procedures for the behavioral sciences. Belmont, California: Brooks/Cole Publishing Co., 1968.

Murphy, H.D., The effect of different locations of chapter summary on immediate and delayed recall. Unpublished doctoral dissertation, George Peabody College for Teachers, 1962.

Platt,J.R., Strong inference. Science, 1964, 146, 347-353.

Proger, B.B., Mann, L. Taylor, R.G. Morris, V.R. & Reckless, D.E., Advance and concurrent conceptual structuring mechanisms in detailed reading passages. Paper presented at the meeting of the American Educational Research Association, Minneapolis, February 1970.

Proger, B.B. Taylor, R.G., Mann, L. Coalson, J.M. and Bayuk, R. J. Conceptual pre-structuring for detailed verbal passages. Journal of Educational Research, 1970, 64, 28 - 34.

Scandura, J.M. and Wells, J.N., Advance organizer in learning abstract mathematics. American Educational Research Journal, 1967, 4, 295-301.

Smith, R.J. and Hess, K.D., The effects of prereading assistance on the comprehension and attitudes of good and poor readers. Research in the Teaching of English, 1969, 3, 166-177.

Thelen, J.N., The use of advance organizers and guide material in viewing science motion pictures in the ninth grade. Unpublished doctoral dissertation, Syracuse University, 1970.

Triezenberg, H.J., Testing for concepts of ecological systems Madison, Wisconsin: Wisconsin Research and Development Center for Cognitive Learning, Practical Paper No. 3, 1968.